

LATE SUMMER FOG USE IN THE DROUGHT DECIDUOUS SHRUB,
ARTEMISIA CALIFORNICA (ASTERACEAE)

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ABSTRACT

Coastal fog affects many California plant species and can be critically important to species that experience periodic drought. Drought-deciduous species in particular rely on water availability to maintain their leaves during the summer. To determine fog water use in drought-deciduous plants, this study manipulated access to fog drip and measured the water relations of the common shrub, *Artemisia californica*, near Santa Barbara, CA. Measuring the stable isotope ratio of hydrogen and oxygen, this study found that *A. californica* uses fog water in the late summer months when fog is present. This additional water increased plant water content but had no effect on pre-dawn xylem pressure potential. While climatic variability inhibits reliable fog input to *A. californica* in Santa Barbara, this species can use fog water opportunistically and benefits from large fog events during the summer drought.

Key Words: *Artemisia*, drought, drought-deciduous, fog, stable isotopes, water relations.

In arid ecosystems, water is often the most limiting factor for plant survival and growth. This water generally comes in the form of rainfall; however, in coastal regions fog water can act as a strong influence on plants (Klemm et al. 2012). Fog provides a significant amount of water to plants in regions as distinct as the Atacama Desert of Chile (Cereceda et al. 1999) and Coastal Redwoods of California (Limm et al. 2009). Ecological studies of fog have explored the response of many plant types to fog water inputs (Corbin et al. 2005, Fischer et al. 2009, Limm et al. 2009, Berry and Smith 2012, Vasey et al. 2012, West et al. 2012). However, research has largely ignored drought-deciduous species, whose leaf phenology responds directly to seasonal water availability. Drought-deciduous plants drop their leaves during seasonal periods of drought as a means of conserving water (Harrison et al. 1971). In coastal California, fog tends to occur in the summer months during peak drought (Williams 2009). This additional water could provide significant physiological benefits for drought-deciduous shrubs along the California coast.

The most common drought-deciduous species along the California coast is *Artemisia californica* Less. (Harrison et al. 1971). This shrub species has high transpiration rates due to weak stomatal control and a thin cuticle (Harrison et al. 1971, Poole and Miller 1975). During periods of summer drought, *A. californica* will shed leaves as a means of reducing water loss. Previous

research suggests that the rooting systems of *A. californica* are shallow compared to evergreen species that grow in the same environment (O'Leary 1990). This enables *A. californica* to respond rapidly to rainfall events but also reduces drought tolerance (Poole and Miller 1975). Considering the weak transpirational control and shallow rooting system of *A. californica*, the acquisition of late summer fog could provide significant physiological benefits if the plants are capable of taking up the fog water.

Fog can affect the water budget of *A. californica* through foliar uptake or through fog drip. Fog drip occurs when water vapor from a low-lying cloud condenses on plant material and then drips into the soil where it can be taken up by the roots. Foliar uptake, or the absorption of water into the plant directly through the leaves, can also provide some physiological benefits (Limm et al. 2009), but appears to be short-lived and has yet to be effectively quantified. As *A. californica* is drought-deciduous in the late summer, foliar uptake is unlikely to affect the shrub as there are few leaves for water to enter. However, the shallow rooting system of *A. californica* may allow this species to take advantage of fog drip that collects in the top layer of soil. In this study, we address the question: Can *Artemisia californica* access fog water and if so, does it affect plant water relations? We used the natural abundances of stable isotopes of water extracted from the xylem of the shrubs before and after fog events to evaluate whether